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VITAL RADIANT ENERGY

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In an article in a previous issue[1] entitled "The Spectrum of Radiant Energy," the writer outlined briefly the characteristics of radiant energy. The following article deals with "vital ultra-violet" and its origin, generation and application to everyday life.

As stated before, the Ancients who worshipped the sun as their God were probably wiser than we give them credit for. I think we can be quite honest in saying that the sunlight which reaches the earth is necessary to about all living matter upon the earth, directly or indirectly. Naturally we are concerned more selfishly with what sunlight has to do about our own living and secondly, about how we can make it do more.

The human blood and the leaves of the trees both contain a pigment; hematin in the blood, chlorophyll in the leaves; both of which are sensitive in their peculiar ways to radiant energy and both of which absorb these radiations and transform them into what we might call the energy of life. The effect of a proper supply of radiant energy is to maintain and prolong life; the effect of a reduced, or over supply, is to hasten death. Man has gained the idea that he can, in a measure, direct his own life and his independence of Nature has greatly increased. It is a very grave error. He has come to believe that his will and knowledge are supreme. He seeks health through the use of man-made remedies, serums, vaccinations, and endeavors to improve upon the body by the use of numerous operations. Health, on the other hand, I believe, comes largely from the sun, man owing his life to it both directly and indirectly.

As optometrists we treat light. One of the arguments in obtaining optometry laws was that optometry treats light before it enters the eye, whereas medicine concerns itself with the treatment of the body itself. But in our daily use of visible light, we often forget all about the invisible ultra-violet (hereinafter referred to as U-V) light which is just below the visible violet. Vital U-V rays are no further below visible violet than the green is from the red in the visible spectrum. U-V rays are classified by many authors in divers ways but it is quite agreed that the narrow band from 3,200 A. U. to 2,900 A. U.

[1]Vol. 6, No. 5, pp. 280-285, 1929.

is the "vital" band. It includes those rays of sunlight which do not pass through ordinary window glass, as shown in Figure 1.

Ultra-Violet and Health

What do these rays do? A few animals live in caves or comparative darkness but man has probably always been an out-of-doors animal. He is adapted to sunlight. On the other hand, many animals who remain in seclusion during the day but are active at night are adapted to a different intensity of light. It is possible that their eyes, like those of ants, are "tuned" to work with different wave lengths than the eyes of man. But even animals living in comparative darkness depend upon the vital action of sunlight to provide their necessities of life. The vital rays of sunlight are necessary to produce the required vitamins in food. Food manufactured and dried in the dark such as breakfast foods can be made to possess more essential vitamins by irradiating them under strong U-V light and this process is now in use by at least one large manufacturer of a variety of breakfast cereals. Most garden vegetables may be grown under glass but they do not have the vital food value or energy building power of vegetbles grown in full sunlight. Most plants will mature after a fashion under glass but animals (including man) would die under similar conditions.

Authorities differ as to just how the U-V rays act upon the body but it is quite agreed that they cause increased perspiration, check increase in body girth, reduce fatness, are invigorating and strengthen flabby muscles. Centuries ago the nation of Greece produced the finest specimens of manhood and womanhood, athletes, poets and thinkers. It is probable that the beauty of form of the Greek has not been equaled since and the Greeks made use of sunlight extensively and frequently bathed in it unclad upon their housetops. Early "physicians" even before the time of Christ advised sun-baths and the Bible gives us a long list of sun-worshippers.

It appears to be proved that U-V rays stimulate the growth of bone, prevent rickets, and often reduce the weight of corpulent persons. They have a strong germicidal action and have long been used in the treatment of tuberculosis. Within the past year many Optometric Journals have given interesting data upon the use of U-V rays for the successful treatment of conjunctivitis, trachoma, corneal ulcers, keratitis and eye-injuries. It is, I believe, essential to the healthy eye and especially for its proper development during youth. Sunlight, strong in U-V, is a powerful opponent to bacteria and when accompanied by dryness, represents rapid death to most of these. Repeated experiments have shown that it is the shorter U-V rays which have this effect. Workers in semi-darkness usually show a reduction in the red cells and hematin content of the blood. They in time become anemic and are unhealthy in body and mentality. Given exposures of artificial or natural sunlight in proper amounts, gradually increased, their blood regains its strength and the worker

Visible and Vital Radiant Energy

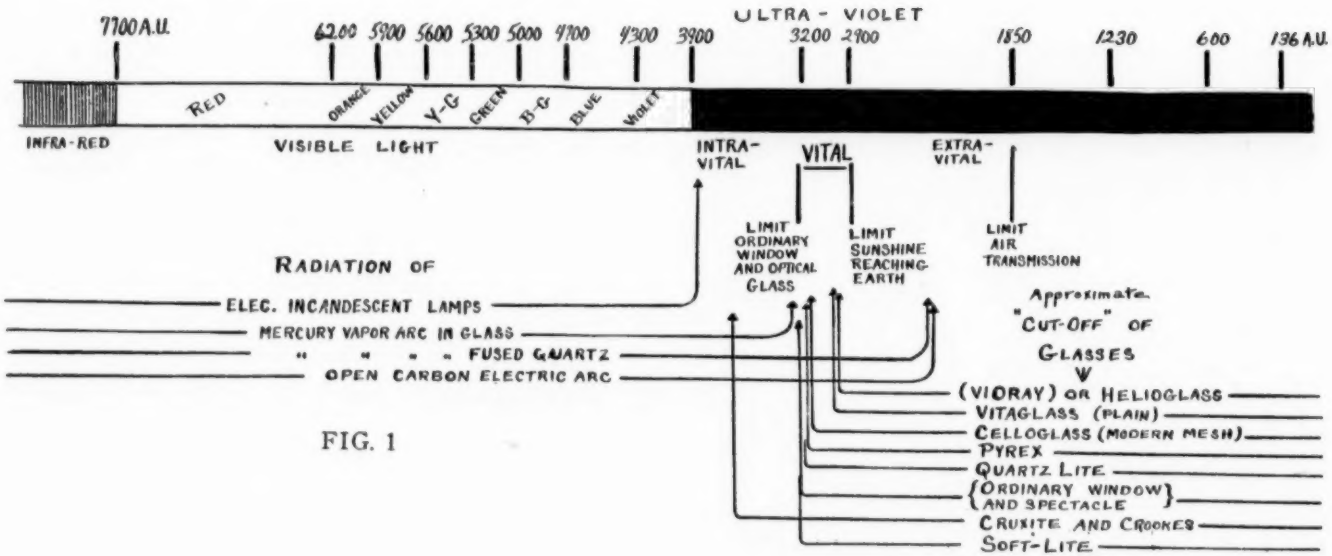

FIG. 1

is greatly improved in health. U-V rays also increase in some individuals the growth of hair, also removing pimples and similar skin blemishes, accelerating the sympathetic nervous system, and increasing glandular activity. Of all persons, pregnant mothers, infants and growing children seem to need ample U-V radiation. Also in the experience, of some observers, notably Luckiesh, in over 500 cases of cancer, four-fifths had lowered calcium content of the blood. Thus suitable U-V radiation if not a positive preventative of cancer is, I believe, at least active in reducing susceptibility to this disease. U-V rays have been found very beneficial in acidosis, asthma, colitis, eczema, gastric ulcer, neurasthenia, neuralgia, neuritis, arthritis, tetany and intestinal ulcers.

How then can we avail ourselves of this vital light? There are two easy methods. First, when workers are confined for long periods of the day indoors (and this includes optometrists) we can make a big step forward by replacing our old windows with special glass which will let in a goodly portion of the vital U-V light. Secondly, we can generate U-V rays artificially by the use of sun-lamps and give our body a few moments' treatment frequently during the winter months. The decoration of our rooms and the kind of clothing we wear also has some bearing as will be shown later.

Window Glass

Some writers state that it makes no difference what kind of window glass we use and add that during the summer months we do not need such "special" glasses as all of us are out-of-doors to some extent and that in the winter months they assert not enough U-V light is present in sunlight to be of any particular advantage. The writer discounts these statements. The observations leading to these, I believe, were made in or about New York City, where a smoky atmosphere prevents the vital U-V from reaching the earth whereas nearly two-thirds of our population resides in smaller communities or rural sections, more accessible to the U-V in sunlight. The fact remains, I believe, that special window glass for transmitting the U-V rays has proven a help even during the winter months in northern latitudes. Repeated tests in the latitude of Toronto from November to and including March show the average shortest measureable radiation to be about 3,040 A. U., which is about half way up in the band of vital U-V.

The subject of special window glass has been of particular interest to people in and about London because of the cloudiness, fogs and smoky atmosphere peculiar to that section. Northern Europe, as a whole, receives less sunlight than most of the United States. New England and the states of the northwest plain do not, as a rule, receive as much sunlight as the remainder of our country. The results of some tests are shown here.

Experiments With and Without Ultra-Violet

An English farmer experimented with pigs by giving them daily exposure to U-V light over a period of ten weeks. A dozen pigs were kept aside and untreated. When the porkers were marketed those which had received U-V treatment were sufficiently fatter and better than the untreated pigs and therefore brought a higher price, enough, in fact, to repay the cost of U-V radiation fourteen times.

The irradiation of cattle with U-V light from a carbon arc lamp a few minutes daily in the winter results in milk with better bone-building qualities. When such a lamp is set up in the poultry house the hens are reported to actually "run for it," ruffle up their feathers just as they do in July, lay more eggs, and lay eggs with thicker shells. Furthermore, such eggs produce a larger percentage of hatchers and the chicks are more vigorous. These are the results of several state experiment stations, notably Maine.

At a horticultural station in Hameln, Germany, several crops of garden lettuce, celery, tomatoes, cauliflower, radishes and kohlrabi were planted in boxes late in March and exposed partly under ordinary window glass and partly under "special" window glass, resulting as follows:

Under "special" glass: 156 beautiful radishes; 37 lettuce heads raised; 90 celery plants raised; tomatoes grew and reached the glass and had to be replanted.

Under ordinary glass: 66 not very good radishes; no lettuce raised; no celery raised; poor development of tomato plants.

In a test with school children at Smethwick, England, a number of boys about ten years of age were divided about equally into two groups and for ten months one group attended school in a room with ordinary window glass while the other group attended school in a room glazed with a "special" window glass. Careful records were kept and at the end of the test the following showing was noted:

	Under ordinary glass	Under "special" glass
Average gain in weight	2.83 lbs.	6.11 lbs.
Average gain in height	1.52 inch	1.86 inch
Average gain in blood haemoglobin	5.73%	16.14%

A tire manufacturer in England had some "special" window glass fitted into his office windows. During the four months prior to the use of the glass his help were laid off for sickness a total of 18 weeks, 6½ days. During the four months *with* the use of the new glass only one day was lost for sickness.

In biologic tests with chickens in groups separated but carefully fed and otherwise cared for the same during January and February the group under ordinary window glass gained in weight 139% while the group under "special" window glass gained 296% in weight. Surely enough gain to pay for the glass in one season. These few

illustrations indicate that there is a definite need for this U-V transmission glass.

In planning the use of such special window glasses there are several things to consider:

First, it is not necessary that the glass be used in windows which receive direct sunlight because light from the north is rich in U-V rays. U-V is reflected somewhat the same as other rays; rooms should be decorated in the lighter tints and such furnishings as are painted should be painted with white-lead paint because many other pigments such as zinc oxide have a greatly reduced ability to reflect the U-V. Common white enamels which often use lithopone as a base have a very low power of reflection for U-V rays. Second, most special window glasses as now made include all of the elements used in ordinary window glass plus four to six others and thus such glass is not quite as clear as ordinary window glass and because of its lower melting point it cannot be polished plane as plate glass and it is subject to some waves and ripples. Third, it comes in slightly thinner sheets averaging about 2 mm. in thickness and thus is not recommended for panes over four square feet in area. And, fourth, the use of outer "storm" windows as is common in colder climates during the winter will of course cut out all vital U-V unless these outside windows are also glazed with special glass in which case the amount of vital U-V which would enter the house would be cut in half.

There seems to be every reason to commend the use of such better window glass where possible as a natural and reasonable way in which to avail ourselves of the benefits of vital light. In stables and poultry houses cheaper products such as cello-glass or cheese cloth could be used to good advantage. It is difficult to see wherein any harm could come from the wide use of these better glasses, and from the evidence before us it would certainly appear that much good could come from a widespread use of this new material.

Generators of Artificial Sunlight

However, there will still remain a portion of our people who would receive little if any benefit from the use of such better window glass. These include those working in places where only artificial light is available or where the daylight through a smoky city air is reflected back and forth between stone buildings and when it reaches the window it has no vital U-V energy left. For such persons and possibly even for those in apparent good health, much benefit may be had from the use of artificial sunlight made at home. Such artificial sunlight must receive a great deal of careful attention because there is an element of danger in its use unless the proper selection of lamp and "exposure" is made.

There are so many "sun-lamps" now offered for sale that a few words about them would be helpful here. It is desirable to have the light as nearly as possible like natural sunlight. Several things

tend to make this difficult of achievement. Many firms offer therapeutic lamps which are nothing more than incandescent lamps enclosed in a big metal reflector with a good handle. Such lamps radiate no vital U-V because such rays will not pass through the glass bulb and the filament operates at such a low temperature that it is very unlikely that there is any vital U-V radiated at the source. As a general rule such lamps are not much more useful than a good hot-water bottle.

Other sun lamps are made using the mercury-vapor arc but if the bulb is of glass no vital U-V rays will pass through it. A mercury-vapor arc lamp with a fused quartz bulb which permits the vital U-V to pass through is a good artificial sun. This however has its objections as will be later shown. In the writer's opinion the most nearly satisfactory approach to natural sunlight is the use of an open carbon arc lamp enclosed in a metal hood except one side which remains open so that nothing is placed between the arc and the patient to cut off any rays from the lamp. A further comparison of these two kinds of artificial suns follows

The efficiency of the mercury-vapor lamp is without question much higher being about forty times as efficient in proportion to the current used as is the open carbon arc. The mercury-vapor lamp is rich in U-V radiation and a lamp of this type using about 4 amperes current will produce erythema (redness of the skin) in about two minutes. A carbon arc lamp on the other hand will require from six to thirty minutes to produce the same effect according to the amount of current used.

A 10 ampere 110 volt carbon arc, which is the largest size permissible to be used without special wiring equipment, will require about thirty minutes to produce the same effect as the 4 ampere mercury-vapor lamp will do in two minutes. If current costs 10 cents per K. W. H. the operating cost for current of the carbon are per "treatment" would thus be 5.5c against .015c for the mercury-vapor lamp. Where time and operating cost is very important as in hospitals the mercury-vapor lamp is of course the only type to use. However, for individual use at home the carbon arc is the best investment because while it costs more to operate, a good carbon arc lamp may be purchased for $35 against $300 to $450 for a good mercury-vapor installation. It will thus be seen that if an individual were to use his sun-lamp for sixty exposures at the rate of four a week during the winter months his cost for current for the carbon arc would be about $3.00 against 10 cents for the mercury-vapor lamp but the lower cost of the lamp more than offsets the higher current cost of the carbon arc for small family use.

Glass as well as quartz decreases in power of transmission with age. After the mercury-vapor arc has been in use a few hundred hours its emission of U-V may fall to as little as two-thirds its original amount but thereafter does not decrease but slightly during the

life of the lamp. Window glass exposed to sunlight for a century or more often becomes considerably colored. Even spectacle lenses in use several years frequently acquire a pronounced amber tint. This same characteristic is also present in the newer types of "special" window glass. Helioglass, for instance, transmits about 63% of the incident U-V when new but after about two weeks' use its transmission drops to about 50% but does not thereafter deteriorate to any appreciable extent.

Caution in Use of Sun Lamps

The intensity of radiation from these artificial sources ought to be considered. At one meter distance from the arc a 20 ampere open carbon arc with a good reflector gives about the same quality and quantity of radiation as does best June sunlight at midday. The 10 ampere carbon arc with a good reflector will give about one-tenth the radiation of June sunlight. The "law of inverse squares" applies in these exposures so that when the body is twice as far away from the lamp a four times longer exposure is needed to produce the same results.

The writer's experience using a 10 ampere, 110 volt, open carbon arc with therapeutic "C" carbons was that best results will be obtained by starting with, say, a six-minute exposure and gradually working up to possibly a half hour exposure at a time. A pronounced tanning occurs about twelve hours after the first exposure which continues to remain with exposures of about eight minutes, four times a week. Some persons tan very easily, others may tan, not so easily and may require much more exposure before much effect is noted. One should endeavor to use artificial sunlight with a safe margin and it is better to err on the side of safety rather than over exposure.

U-V light is not considered a cure-all or a panacea for all our ills and neither should any individual go out at once and bathe unclad in the noon-day sun. A correct amount of U-V is essential for us but too little or too much of it is harmful. Then too, people must adapt themselves slowly so that the first exposure should be brief and for only a part of the body then followed by gradually lengthened exposure and increase in the body area exposed. This rule applies to both artificial and natural sunlight.

The carbon arc gives, of all artificial illuminants, the nearest approach to natural sunlight. The mercury-vapor lamp is proportionately much richer in the U-V region than sunlight and thus requires much less time to produce erythema. On the other hand, we feel one should follow Nature as closely as possible and that the longer exposure under the open carbon arc with its visible and infrared radiation would be the better.

Other things to bear in mind with sun lamps is that the source of light is much nearer than the source of sunlight and that the rays are divergent instead of parallel and that the amount of heat

radiation is greater than in sunlight. Thus it is absolutely imperative *to wear closely fitted, heavily smoked goggles when using such lamps and to avoid over exposure because of the danger from burning.* If one awakens early in the morning with an uncomfortable itching or smarting sensation it is evidence that the exposure the evening before was too long. In tuberculosis and in rickets and similar conditions daily exposures of two hours are common but the inexperienced should not attempt long exposures.

As a general rule exposures should not be attempted in pellagra, small-pox, any of the fevers, in albinos or persons lacking natural pigment, where the skin has any coarse fibrous growths, where the person has previously suffered from sun-stroke or malarial fever, or who is subject to freckles and does not wish them increased, or one who has hives, a too active thyroid, or hay-fever. In some hay-fever cases where the blood has a low calcium content U-V can be very helpful. In other cases of hay-fever, U-V is often the exciting cause.

After exposure a reddening occurs due to the increased circulation of the blood in the area radiated. Some of the blood pigment remains and the skin becomes tanned. As the tanning is increased the body is able to absorb more U-V and withstand longer exposures. Blondes usually sunburn instead of tanning but brunettes always tan. Blondes are adapted to work with less U-V radiation than brunettes and are better adapted to the climate of our northern states.

The effects of such exposures to artificial sunlight are clearing up of skin blemishes, improvement in body weight, reduction of blood pressure, improvement in the condition of the blood, a feeling of "well being," increased body tone and activity and increased resistance to disease in addition to all of the benefits which have been credited to sunlight earlier in this article. Reasonable exposure stimulates growth but an over-exposure is destructive.

Other Ways to Have Ultra-Violet

People living in the northern latitudes often "can hardly wait" for the first days of Spring and are eager to get out of doors once more. The reason is none other than the natural craving for some more vital U-V light to "tone" us up again. The thought naturally occurs—"Cannot we obtain the benefits of the vital U-V rays without going to the expense and bother of reglazing our windows and buying artificial sunlight?" In a small way we can. We can use a diet rich in those foods which grow in full sunlight. Among the leaders would be spinach, endives, lettuce, asparagus, fruits, cereals, berries, figs, dates, etc.

The economic condition and surroundings of most professional men, and especially of optometrists, are such as to deprive them from getting their full share of U-V, which is so essential to health. It would be highly advisable to make it a rule to keep the windows at

home and at the office opened as much of the time as is possible. And where this is not possible or practical, then the ordinary window glasses should be replaced by some of the new kinds of glass which transmit the vital rays of sunlight. This suggestion should also be applied to our closed car windows. Another step would be to wear loosely woven clothing. It was formerly thought that U-V would pass through cotton but not through wool. Experiments at the U. S. Bureau of Standards have shown that it is the nature of the weave rather than the kind of material which determined this. The looser the weave the more U-V you get through it. But clothing of the same mesh per inch differs in transmission of U-V according to its color. Black cloth absorbs U-V as it does heat and light rays but white goods will pass through more U-V at the same time reflecting the heat and light rays better.

When you go on your vacation, go to the mountains, and the higher up you go the more U-V you find. Many sufferers from hay-fever and tuberculosis have long been recommended to higher altitudes. The presence of more U-V at the higher altitudes has been largely the secret of the cure in such cases. If it were not for the ability of the sea to reflect U-V there would be very little of it at the seashore. The reflection of snow, ice and water for U-V is very high and accounts for much of the eyestrain under such conditions of glare.

Speaking of calcium content of the blood and its increase by U-V radiation recalls the statement of Hume that in nearly all cases of fully developed myopia a lowered calcium content of the blood can be found. The origin of the myopia is said to be caused by the weakened sclerotic coat and posterior pole of the eye. We know that myopes are indoor humans as a rule and prefer a good book to outdoor sports. It is possible that the deficiency of U-V radiation may have something to do with the rapid development of myopia. It should prove an interesting field for investigation.

All the above data on vital U-V and the spectral transmission of various glasses will cause many optometrists to ask, "What about tinted spectacle lenses" and "What about U-V as a cause of cataract?" While either of these are interesting subjects, space does not permit for their discussion, and we shall write an article dealing with these questions at some future time.

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REPORT OF THE TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY.

The meeting continued[1] with Chairman Dr. E. G. Wiseman occupying the chair. Dr. Wiseman introduced Dr. E. LeRoy Ryer, who presented a paper on the *"The Control of Myopia by Reverse Stereoscope."* This paper was published in full in this Journal, Vol. 5, No. 2, pp. 59-64, 1928. At the close of Dr. Ryer's address the chair was taken by Dr. J. H. Drakeford who introduced the Chairman, Dr. E. G. Wiseman.

THE EVOLUTION OF THE VISUAL APPARATUS

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Evolution of the Animal

Most, if not all, animals begin as single cells. Some remain such, as in the case of the amoeba. Others multiply almost endlessly and develop into higher animals.

The unicellular animals—protozoa—are quite as complete units of life as the multicelled—metozoa. The amoeba, for instance, hunts, swallows and digests food and ejects debris. It is quite capable of maintaining its existence under harmonious conditions, and of multiplying its kind.

In some respects, it is even more versatile than more complex animals. It can extend an "arm" or "leg" at will from any part of its "body." It is all eye and all stomach, for example; in fine, it can make nearly any part of its structure perform in any way in which the whole or any other part can perform.

When it desires food, it simply extends itself on either side of the desired particle, thus acting as a mouth, brings the two ends together, thus swallowing, and then proceeds to digest. When this process is completed, it moves on, leaving the debris behind. When desiring to propagate itself, it divides in the middle, and, presto, it has become twins. Another division and it is a family, and so on, ad infinitum. As far as the raw maintenance of life is concerned, higher animals can do no more. They extend their operations and perform more complicated functions but, until very high grades of animal life are

[1]December 6th, 1927.

reached, there is ground to wonder if the difference is any more than one of magnitude.

Having succeeded with the single cell, Nature moved on to the two-cell, the three-cell and so on to the much higher-celled animals. But soon she had to employ greater ingenuity than in single cell construction. Cells must live, and to live they must have contact with the source of food supply. If cells in a group become too numerous, those inside will be shut off. Of course, it would be possible to extend a string of cells indefinitely, but then its effectiveness would be lessened and its susceptibility to destruction would become greater.

And so Nature solved the problem by depressing the group in the middle and folding up the sides, thus forming a relatively short tube, and causing the individual cells to take on specialized functions. As cells became buried when the walls of the tube thickened, she built canals (blood vessels) to them and constructed special cells (blood corpuscles) to carry food to them and waste material away from them. Instead of remaining independent units, the cells became interdependent and acted as a whole and for the benefit of the whole.

When the conditions became such that the more complex animal could no longer depend upon the medium in which it lived to bring it food, it became necessary for it to move about more or less actively. To facilitate this, Nature constructed a special group of cells (muscles) having the power of contractility. Those she attached to another special group (bones or shells) and arranged the whole so that the animal could propel its body in the direction of food or away from danger.

In its earliest development, probably the life of the animal was conditioned upon simple chemical action and reaction. It might even be that positive and negative charges of electricity played their part. But in the higher forms, it is evident that complexities developed. It became necessary to convey the chemical and electrical entities from one cell or group of cells to distant cells, and to do this with a minimum loss of potentiality and a minimum disturbance of intermediate cells.

We have mentioned the blood stream as one agent for this purpose. When muscle cells were created it became necessary to invent another conducting system. And so nerves came into being. These carried impulses from one part of the animal to another and caused that other to act for the preservation of the animal as a whole. This implies intelligence—of a kind. We do not mean intelligence as the word is ordinarily used but the sheer physical ability to receive sensations from the external world and interpret them as beneficial or malevolent.

The tube-like animal developed this ability in three areas—the external layer of cells, the internal lining of cells and the intermediate or deep cells. Probably the reactions at first were, as suggested, purely chemical. Later, or perhaps even coincidentally, they became mechanical, and thus, we may say, the sense of contact or touch was started on the way to development.

As the structure became still more complicated, Nature found it still more necessary to do what we humans do when we have a large disorganized body which it is desirable to preserve. She established a center of control—an area which co-ordinated all the impulses received by the body and regulated them so that antagonistic forces would be harmonized and economy of operation would be assured.

This we call the central nervous system. When any part of the animal received an impression, it was sent to the central nervous system for interpretation. If understood to be beneficent, orders were sent to a certain group of cells to act in a certain way. If harmful, another group were called upon to respond in the particular way for which they were constructed. Thus the animal was equipped to accept conditions favorable to its existence or reject those unfavorable.

But as the animal grew still further in complexity and as the struggle for existence grew more intense and involved, it was not enough to possess tactile sense. It became necessary to recognize the friend or enemy to its existence before actual contact was established. Hence, special areas of the animal grew in sensibility to external influences.

One developed taste, enabling the animal to select food before taking it into the body. That was only a slight advance over the tactile sense.

Another went farther and recognized minute emanations from the distant object. That constituted the sense of smell, and projected the animal's power of recognition quite a distance beyond the body.

But this was not far enough, and so another group of cells recognized physical vibrations of the medium in which it lived, and thus hearing was born. This extended the field of observation greatly.

Still it was not great enough. Danger could approach silently and the animal be destroyed before it had the slightest opportunity to fight or flee. It became necessary otherwise to be able to recognize friend or enemy.

A special patch of outer cells—skin—became sensitized to light, and thus the first eye was born. This projected the animal's intelligence into a vast area and made it possible to move around more freely and more safely. Enemies could be avoided and food more easily obtained. The continued existence of the animal became assured.

No one can say how much farther the animal may be developed. It may be growing rudimentary cells which will still more greatly augment its power. As we view existence today, it is plausible to surmise that the animal's next sense will enable it to read the minds of others, since the dangers of physical contact are growing less (despite the automobile) and the desirability of anticipating accurately the designs of those inimical to our safety is necessary. However, we have enough, in these lectures, in dealing with the past and present.

Evolution of Man

If we take the liberty of passing over certain stages of existence, we may say that the first man was a fish. It grew an articulated vertebra and possessed the power of relatively rapid motility. To increase its speed it developed fins. It became so highly evolved that it grew dissatisfied with its environment—even as humans do today—and flopped out onto the land. Its fins altered into arms and legs, it walked erect, it climbed trees and now it can perform the most intricate motions with the various members of its body. It even again is becoming dissatisfied with its element and is aspiring to fly. Possibly when gliders are developed to the stage where this glorified fish can propel himself in the air from place to place by arm and leg power he will literally conquer the air and not depend upon machinery to do it for him.

The evidence of this development, stage by stage, still exists in the life upon this planet today. Step by step it can be observed. There are fish which flop upon the land and climb trees. The tadpole is almost precisely similar to the spermatozoa of man, and it grows legs and rudimentary arms and becomes a frog. The saurian has four legs and a tail much like a fish. It lives partly in and partly out of the water. There are animals which lay eggs and others that fly. Others possess further evidence of relationship to both fish and fowl and other animals. The chain of evidence from amoeba to man is fairly complete. A missing link here and there does not destroy the clear proof of a connection.

In each step of his growth from one cell to 26 trillion, the varied functions which man has developed have in some cases increased in effectiveness and in others decreased. As his environment has changed, the value of his senses has changed with it. Nature wastes little and seldom maintains two organs when one will serve the purpose.

Hence, as man's intelligence became greater and the power of observation and rapid analysis grew, some of the higher functions seem to have declined. Either that or they did not develop in man as in other animals. For instance, his tactile sense is greatly inferior to some low grade insects. His olfactory acuteness cannot begin to compare with that of some insects and other animals. His acuteness of hearing is very low and his sight is decidedly inferior—apparently both in the visible scale of the spectrum and then of course outside it, for there seem to be eyes which register rays that are absolutely nonexistent to man.

In the first group are the birds which apparently possess vision a hundred times as acute as man's. That explains how vultures, for example, will flock around a dead animal twenty minutes after it has been killed, although the death has occurred miles out in the desert and no vultures have been visible anywhere to the human eye.

In the second group are such insects as mosquitoes to whom the human body is said to glow in the dark like a red hot piece of metal. Perhaps bats come in a somewhat similar category, since they can

fly around an absolutely dark cavern and never touch the wall. However, in that case other senses are more likely to be the dominant ones—hearing and smell.

But in one respect man's sensory equipment rises superior to that of all other animals. He normally possesses binocular single vision. His two eyes fix upon the same object at the same time. No other animal possesses this function as a constant, and only the higher apes possess it intermittently. In all others the eyes are fixed alternatively and the fields of vision either do not meet at all or they only partially overlap. In man they exactly coincide and form one. This situation constitutes a form of unconscious triangulation and enables man to judge distance more or less accurately without depending entirely upon memory.

Doubtless, in some of the lower animals this function is yet in the process of evolution. Perhaps because of its early growth in man he is today the highest developed animal on earth.

Let us see how this may have come about. When fishes inaugurated the first May day movement, they doubtless were accompanied by other animals. Or some fish were different from others. As they separated and developed along different lines, some varieties of these creatures began to devour other varieties, just as they do today, both on land and in water.

Naturally, the instinct of self preservation asserted itself and the weaker creatures began to cast about for means of preserving themselves. Not being stronger, they had to resort to strategy or flight. Not being fleet enough on the ground, they literally "took to the tall timber" and began to live in trees.

Now it is one thing to climb trees as a diversion or to avoid danger and quite another to live in them constantly. The latter requires great agility and more or less speed.

Even these were not enough, however. Accurate judgment of distance was imperative. It would be fatal to swing from one branch or tree to another and underestimate its distance by a matter of inches, especially if the jaws of a hungry animal were open beneath.

And so Nature constantly pushed the eyes forward until at last their lines of vision intermittently at least met at the object viewed and the animal could calculate accurately the distance of the limb or the cocoanut or any other thing it wanted to grasp.

All of this implies the development of greater intelligence. This animal used its brain to avoid danger and its brain grew as it was used. Very likely the acquisition of stereoscopic vision gave a tremendous impulse to the cerebral cortex, and that particular species of fish-monkey-man rapidly surpassed all others of its cousins. Except in a special sense, it did not necessarily descend from such monkeys as exist today. It *may* have descended from the same kind of *fish* but its tribal life probably was lived apart from its cousins and it certainly surpassed them in its intellectual progress.

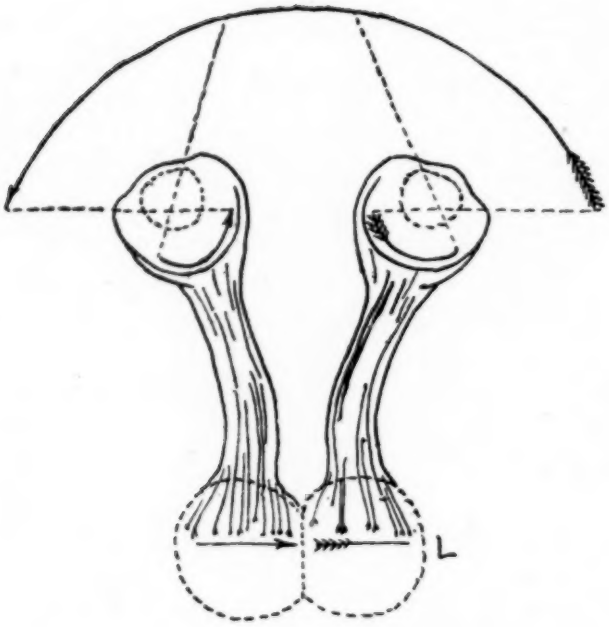

Figure One. Diagram showing the distortion of the mental image of an object in lower vertebrates without an optic chiasm. (Cajal.) L—Visual Center.

With the acquisition of stereoscopic vision, which eventually became an habitual function, it is natural to assume that our monkey-man developed confidence and manual skill and cunning. Eventually he came down from the trees—another man-like evidence of dissatisfaction with environment—and walked the earth, pitting his intelligence against the brute force of his enemies. Today he is master of all and has assured his continued existence to such an extent that he bids fair to over-run the earth and literally devour himself out of house and home.

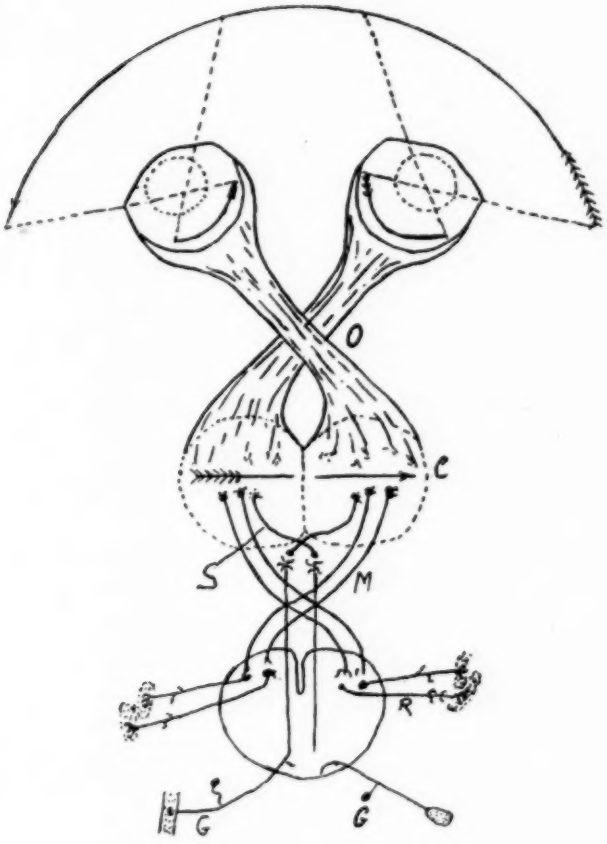

Figure Two. Diagram showing the usefulness of the optic chiasm and the compensatory decussations of the motor and sensory tracts in the lower vertebrates. (Cajal.) C—Secondary Visual Centers, showing incompleteness of each field. G—Spinal ganglia and sensory roots. M—Crossed motor tract. O—Crossed optic nerves. R—Motor roots of the spinal cord. S—Central termination of crossed sensory tract.

From all this it seems safe to assume that the dominating factor in man's development from the time he "landed" up to the present was his visual sense and all that involves. It will be interesting and valuable, then, to look more closely into this subject and note just how the organ of vision and its connections have developed.

Evolution of the Visual Apparatus

The first visual organ was a supersensitized patch of skin. Perhaps its first function was to recognize the thermal value of light so that the animal could become conscious of the existence of an object foreign to its environment when the latter came between it and the source of heat. Commonly, there were two of these patches, one on each side of the body, although they possessed great variety and were located in many different places.

Their exposed position permitted injury too easily, so Nature's next step was to sink them into little hollows. That was better, but still sand got into them and spoiled their effectiveness.

Then she covered them over with a jelly-like substance and that again was an advance but it did not keep out the stand. And so she grew a hard, celluloid-like transparent layer—the cornea—over the jelly and at last attained a measure of real protection.

Along with all this there was a simultaneous development of an optic nerve which conveyed information to the central nervous system. This was rudimentary but it served its purpose.

The results of this embryo eye must have been so pleasing that Nature began in earnest to experiment with the construction of a practical seeing organ. The transparent covering she made convex so that the light tended to focus on the nerve endings behind the jelly-like filling. Into the latter she introduced a hardened group of cells which she shaped into a lens and thus doubly insured a focusing apparatus—a compound eye.

Since an eye which rigidly pointed in only one direction necessitated constant movement of the entire head and body, she enclosed it in a tough spherical membrane—the sclerotic coat, freed this from all connections but the optic nerve and permitted it to roll in its socket. So that it might roll deliberately, she attached muscles to it, thus permitting the brain to assume control and point the eye in different directions. That saved the head and body a lot of work.

To the cornea she supplied sensory nerves that the presence of harmful agencies might be known, and over the cornea a curtain—the lid—which could be slid at will—another form of protection. Behind the cornea she placed another curtain—the iris—with a hole in it so that the amount of light penetrating to the now extraordinarily sensitive optic nerve could be regulated.

Basically, this is the eye humans possess today. There are many other varieties, all testifying to Nature's ingenuity in constructing experimental mechanisms. But these we can pass over and concentrate upon the main object of this study.

The fish was a very useful progenitor of man. From it we get our vertebra, our brain box, our ears, our spinal cord, our cage of bones for the protection of internal organs. Bones that are inside the body instead of outside—shells.

And from it seemingly our eyes. It is a pity we did not inherit also the electric light plant some fishes carry with them—shooting beams out of port holes in their bodies so they can see surrounding conditions. But, the fish cannot build a fire, so perhaps we are even there.

When the fish left the water its eyes began to move forward in the head. We could jump a few million years and state that they continued moving from a position where their axes formed a straight line directly through the head of the fish until they became parallel, as in man, but the evolution of the visual apparatus is too important to pass thus perfunctorily. One eye, yes, but not two.

We may safely suspect that the change from continuous axes *across* the median plane of the animal to parallel axes *along* the median plane, produced profound changes in the entire mechanism. And so it did.

But to understand this thoroughly, let us go back a little farther —to the ancestors of the fish's eyes. Probably the first pair of eyes, located as are the fish's, each had an individual optic nerve leading to the brain on the *same side.* This produced cerebral pictures as illustrated in Fig. 1.

Very likely the right sight center was connected by nerve fibers with motor apparatus on the right side, and so the animal could push itself away from an unfriendly object, observed by the right eye, or pull itself toward a friendly one. It may have possessed the power to suppress the image seen on the other side by the left eye, or at least it exercised some judgment as to its character and permitted dominancy of either image as circumstances dictated.

During the period of development between this ancestor and the fish, the optic nerves *crossed* each other, and thus the right eye was connected with the left half of the brain, and the left eye with the right half. Possibly this was in the interest of self preservation, and had something to do with developing musculature.

The cerebral result of this crossing (decussation) is shown in Fig. 2. Here it will be observed that while the mental image of the vertebrate's environment is reversed and divided, each half bears its proper relationship to the other. As the eyes moved forward, we see by Fig. 3 that the halves are joined and form a continuous image. Thus, without any motion at all the animal could view at once the entire front half of its environment, and probably 50% of that which lay behind. Even now man, with his eyes entirely in front, can see 190% of his surroundings without moving his eyes. He sacrifices most of that which lies behind in order to obtain stereoscopic vision but there is some compensation for this in his very flexible neck

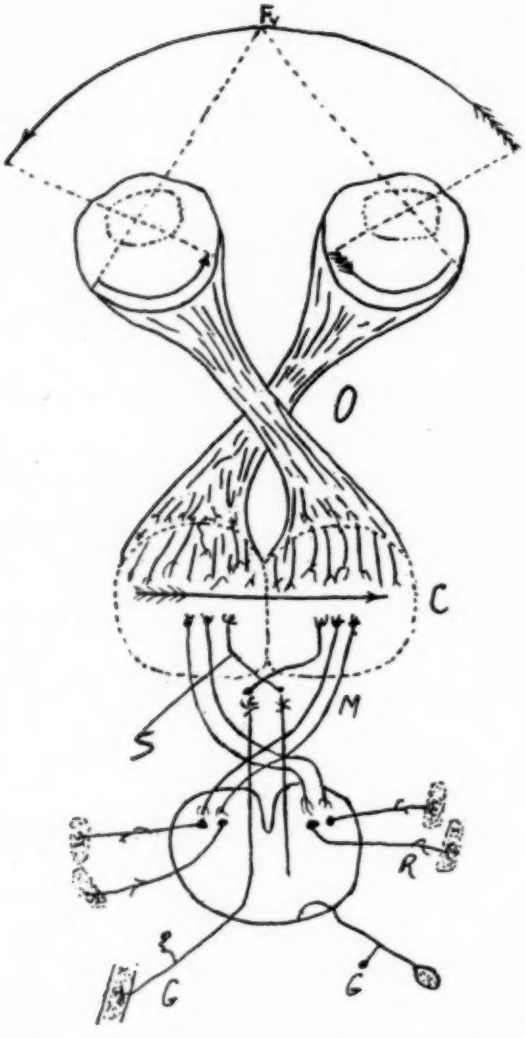

Figure Three. Diagram showing complete fields. C—Shows the completeness of the fields, and Fv showing the common point of meeting of the temporal extremity of each visual field.

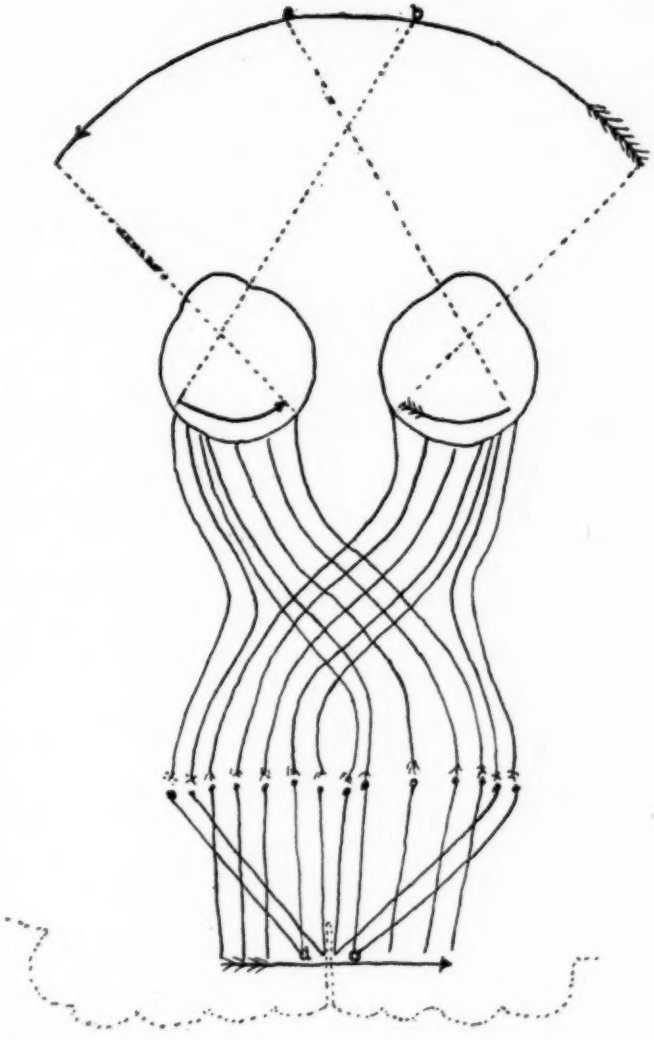

Figure Four. Diagram showing a partial overlapping of the visual fields which necessitated a rearrangement of the decussating nerve fibers. Stereopsis was limited to the area restricted by the extent of the overlapping of the visual fields. a-b, d-c shows stereoscopic area in visual cortex.

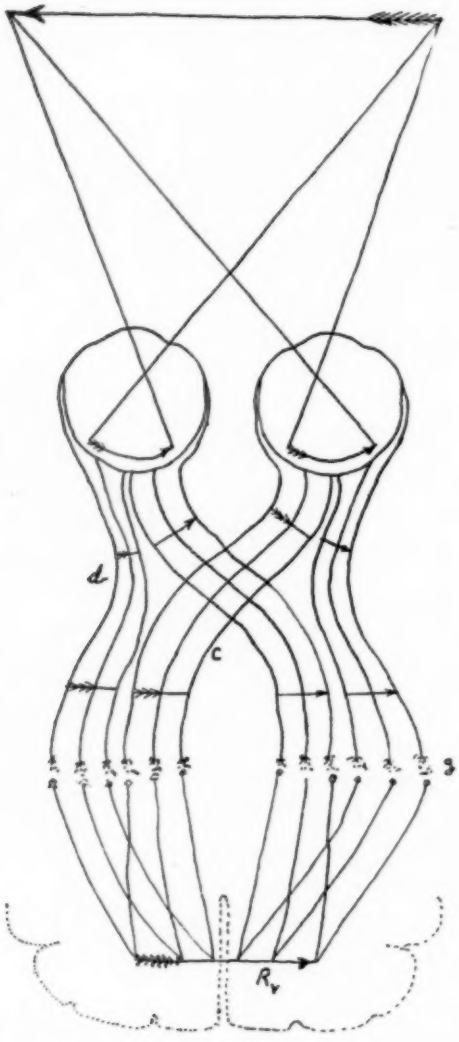

Figure Five. Diagram of the chiasm of the optic tracts and the central projection in man. (Cajal.) c—Crossed fasciculus of the optic nerve. d—External geniculate body. Rv—Projection of the mental image in the visual cortex of the brain.

which permits wide and rapid excursions to the side. We touch upon this later.

From this point onward the real complications of the nervous system develop. As the eyes moved still farther forward the visual fields overlapped proportionately. Each eye began to get glimpses of the same object simultaneously—indirectly, to be sure, but none the less real. There being no special reason why two portions of the brain should serve the same purpose without added profit, Nature began to split the optic nerve, retaining on the same side of the cerebral cortex those fibers which carried images duplicated by the other eye in the opposite side of the brain. Thus there occurred an overlapping of the fields as seen by the two eyes, as in Fig. 4.

Doubtless this partial overlapping permitted a crude, elementary form of stereopsis to exist, for in certain kinds of defective human eyes where it is obvious that each eye is not fixing the same object at the same time, single vision exists and a measure of stereopsis is demonstrable. This is explained by the ability of the brain often to emphasize or suppress the sensibility of any particular area which might arouse or permit obnoxious disturbances if allowed to function as it normally does.

These ocular defects in man are among the most difficult with which the specialist has to contend, for they have superinduced cortical changes, and thus unconscious habits which have been years in developing must be broken down before the eyes will begin to function as a single unit in a normal manner.

As the two eyes pushed still farther forward, the fields overlapped more and more until finally they precisely coincided and thus stereoscopic vision was born and Nature had achieved her ultimate aim. The optic nerves in man are found to be so divided that the right and left halves of the visual area in the cortex each register the images as seen by the right and left halves of both eyes respectively, as shown in Fig. 5. In the lower vertebrate this beautiful matching does not occur. It not only insures stereoscopic vision but guarantees full, or almost full, front vision if one eye is blinded or if one half of the cerebral cortex is destroyed or even if the optic nerves are severed in the median plane as they join and partially cross. In the latter case each eye still possesses half a field.

Coincident with the growth of this semi-decussation of the optic nerves, almost the entire central nervous system of the animal undergoes similar changes. Groups of muscles must have nervous connections with both halves of the brain and, in a sense, with each other, in order that they can co-operate and harmoniously respond positively or negatively to sensations received by either half of the visual brain. Thus there developed a crossing and re-crossing of nerve fibers in the entire central system and a most extraordinary net work of tracts which we are just beginning to unravel, despite the years which have been devoted to study of them.

This crossing of fibers has such an important bearing upon our present study that we quote as follows from Tilney and Riley:[1]

"For what purpose or as the result of what causes the great fiber-crossings occur in the neuraxis is not clearly understood. Cajal, however, offers an explanation concerning decussation in general which seems as logical as it is ingenious. All decussations of tracts, according to Cajal's interpretation, depend upon the character of the vertebrate eye. The hemispherical, concave retinae with the biconvex lenses of the eyes make it essential that the optic fibers shall decussate in order that a proper mental perception of external objects may be created. Cajal believes that the crossing of the optic fibers was, in all probability, inaugurated in the fish and cephalopoda. Primitively this decussation was complete and served as the organic means of determining a mental fusion of the separate visual images received by the two eyes. The corrected visual perception could not be created without the existence of a bilateral center in the brain, each half of which co-operated with the other. The optic decussation established the proper relations between these bilateral visual centers and the two eyes. Furthermore, it exerted a decisive influence upon other pathways in the nervous system, consequent upon the reversal of the mental image in the brain. This reversal of the mental image necessitated a compensatory crossing of other tracts, especially in the motor pathway. Such compensatory motor decussation in turn determined a crossing of the sensory tracts. In this manner the character of the vertebrate eye, which in the first instance enforced the complete crossing of the optic fibers, ultimately determined all decussations within the central nervous system."

Influence of Eyes Upon Mind and Health

From all the evidence on hand it is easy to deduce that the growth of the visual system had more to do with the elaboration of the animal's physical state than perhaps any other factor. That it played quite as important a part in its intellectual growth also is perhaps not quite so acutely realized.

Physical areas grow through activity. Physical activity which is based upon deliberate calculation necessarily arouses cerebral processes, which in turn expand and are capable of initiating more elaborate and intricate anatomical movements. Thus there is a complementary development of both areas—the calculating mental and the responding physical—both being also stimulating; hence, the "itch" to perform some kind of work after a period of idleness.

If deliberate and skilled movements require thought, the fact presupposes thought mechanism, and the existence of the latter implies the existence of muscular and nervous mechanisms to carry out the command. Hence all of these are developed more or less simultaneously. After repeated experience, the deliberate factor becomes burdensome to the mind and the process takes place more or less

[1] "The Form and Function of the Central Nervous System."

automatically—mechanically—subconsciously. This permits the mind to devote itself to other affairs.

The intermediary between primary brain activity and muscle is usually the visual system. The dancer at first looks at his feet, the pianist at his fingers, the writer at his fingers or the end of a pencil. They all get mental images of the act to be performed. These images are retained in the mind even after the act has become so habitual as never again to be thought of.

The mind is largely built up of these images. It has been determined that over 80% of the knowledge which we get we obtain through the eyes. Since we retain the resultant images and since the brain is the physical counterpart of the mind—or the "home" of the mind—it is obvious that as the mind grows, the brain also must grow. If we "create" a new cell for each new image and each new thought, it is obvious that no matter how small the cell, the bulk of the aggregate is bound to grow to considerable proportions. That is why the human brain is larger in proportion to body than most animals. But size does not necessarily mean brain power, for a few creatures—species of birds, monkeys and mice—possess relatively larger brains than man, and often idiots have larger brains than geniuses. The factor of quality enters, and the size of cells, and the use to which cells are put. It is conceivable that brain cells atrophy from non-use and that large areas possessing potential capability are permitted to lie idle, through lack of incentive which stimulates activity. Few if any individuals use their brains 100% and most use their brains to hardly 10% of their thought-capacity.

Those areas of the brain used in the act of vision are numerous and some are large. There are twelve principal cranial nerves and, of these, four are devoted exclusively to the eyes, two others have definite eye associations and a part of the great sympathetic system is directly connected with the eyes. This suggests the relative importance of the visual system to the rest of the body functions with regard to at least the intellectual development of the human animal.

The muscular system of the eyes is, of course, the counterpart of the nervous system. It is said to be the most complicated and delicate in the entire body. There are six muscles which rotate each eye, two which control the iris and one compound muscle which adjusts the focusing apparatus, thus making a total of eighteen for both eyes. These eighteen muscles are called upon to make tens of thousands of instantaneous adjustments each day and these must be made with infinite exactitude. It should not be surprising that when each adjustment is made under stress, as in defective eyes, very real symptoms of discomfort arise. Nor should it occasion wonder that, since the visual system occupies such a tremendously important position, nature will pour into the eyes energy routed from its natural destination in other organs in order to obtain clear and stereoscopic pic-

tures for the brain, with the result that often these other organs suffer and protest and then manifest the symptoms of local defects.

When normal, the human body begins life as a well balanced mechanism. All organs function smoothly and there are therefore no organic stresses to cause discomfort. But when there is abnormality, upon its extent depends the comfort, health, the sanity, the life of the individual.

Whether or not it is true that few begin life with perfect bodies and functions, it is indubitable that only a small percentage—if indeed any—continue to remain normal very long. If they are physically perfect, they soon introduce into their minds or their bodies disturbing factors—thoughts which disrupt orderly mental processes and often react detrimentally upon such physical activities as digestion and blood flow, and food which, when not primarily poisonous, is chemically split into poisonous elements and injures delicate functional mechanisms. It can even affect the mind itself and may ultimately kill the individual.

It is said that few are born with perfect eyes. Some scientists say that all are hyperopic, though "Fuchs" states that 5% are myopic. The latter condition tends to increase and then decrease in later years, and the former to decrease and then increase. As we shall later point out, some of the theories intended to explain these changes are based upon entirely false premises. They are primarily functional and not anatomical, as has long been thought, with the possible exception of those occurring in the first few years of the individual's life, though there also the factor of function plays its part and modifies anatomical changes.

Aside from mentioning that the newly-born has not complete control over the movements of the eyes and that they therefore fail to co-ordinate until some months have passed, scientists have had little to say about the status of the rotating musculature in the child. The generally accepted fact that it was useless to expect exact measurements until the stereoscopic sense was established discouraged and even rendered useless any attempts at mensuration. And when the fusional sense finally "set," the apparent status of perfect equilibrium was accepted as indicating ideally adjusted and innervated muscles.

It has recently been discovered that this ideal condition is not as common as supposed. If we could take a group of infants and suitably observe for a period of five or ten years their rotary ocular muscles we might be surprised by the results. It is quite possible that these would be found to be defective quite as frequently as the refractive condition—that the condition of apparent orthophoria is usually false—that exophoria is the natural status of the ocular muscles when at complete rest.

We would not be justified in expecting anything else. Binocular single vision is the latest acquirement by the visual apparatus of man. Naturally, it possesses the incompleteness of most new mechanisms. Since it is the last stage in the progress of the eyes from the side to

the front, it is quite natural that if there is any tendency from parallelism it is toward divergence.

It is not necessary to depend upon reasoning to establish the merit of this idea. Anatomists say all eyes diverge in death. They diverge in sleep. The axes of the orbits diverge. There are more muscles controling convergence than influence divergence. If a pair of eyes are orthophoric, and the muscles are under normal tonus, the removal of this tonus from all muscles will naturally have a greater effect upon the convergence than upon the divergence factor. Consequently the total relaxation will result in the eyes turning out.

Actually, the postulate ceases to be uncertain, in the light of recent investigations, because it is found that a very much higher percentage of eyes do have the divergence tendency than has heretofore been supposed. Indeed, most esophores are found to be exophores, notwithstanding the assertion of the perhaps most eminent investigator of the motor apparatus of the eyes that esophoria is the commonest defect.

Since the desire for stereoscopic vision is the dominant trait of the normal visual mind, it is natural that any tendency of the visual axes away from parallelism will be strongly combated. Rarely the desire for *clear* images overcomes the desire for *single* images, and the eyes converge or diverge to excess but that is not common compared with the determination of the brain to have stereoscopic vision at the expense of clarity.

In combating diplopia, the motor centers of the nerves which control the muscles are called upon for action. There is such an intimate relationship between these centers that activity of one involves activity of another. It so happens that in one instance this co-activity results in increasing one kind of optical defect and decreasing another or even of transforming the latter into the former by the same process. In the early stages, it is possible to reveal the true state of affairs by utilizing suitable appliances but later the visual mechanism becomes "set" and cannot be relaxed.

In consequence of these discoveries, all previous statistics concerning the relative prevalence of various eye defects may be questioned as to their usefulness. So, also, may we question the value of findings in individual cases. In the light of this new knowledge, cases apparently orthophoric are found to be exophoric, those that have been diagnosed as esophoric are orthophoric or exophoric. Myopia and emmetropia are found to be hyperopia, and slight hyperopia is discovered to be higher hyperopia.

This all implies strain. It means far greater strain than has hitherto been suspected. Despite the broadness of the claims concerning the great variety of ills which can arise from eye-strain, the number can still be more greatly increased. At least, the number of individuals affected can be greatly increased, for many who for years have had the very best attention and who thought their eyes were free from strain are now found to be the most severe sufferers from it.

(Adjournment.)

OCULAR ELECTROTHERAPY

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CHAPTER VIII.

THE PHYSIOLOGICAL EFFECTS OF THERAPEUTIC CURRENTS

Physiological Effects of Diathermia.

The effect of diathermia is the constant and instant formation of heat in the path between the electrodes. The heat is present most in the area of greatest resistance and some of it will be present at all points.

Diathermy, claims Sampson[35], causes the immediate development of an arterial hyperemia thus bringing much more arterial blood than normal to the part and sending more venus blood and lymph out of the part between the electrodes. This arterial hyperemia is said to last for several hours after the treatment, and increases local metabolism, for the process of osmosis (interchange of gases and fluids through the membranes) is accelerated. The heat formed causes the absorption of any unorganized exudate present, and also prevents organization and subsequent interference with nutrition and accelerates repairs.

The heat formed locally is taken up by the blood poured into the heart and acts as the finest "heart tonic." This is claimed to be the only physiologic tonic which does not have any toxic properties. The heart under this condition, of increased tone, causes more heated blood to be pumped to all parts of the body, the internal secretory glands sharing in this general stimulus thus markedly accelerating general metabolism. Increased local heat induces the development of local phagocytosis, and the phagocytes are much more active under this condition.

The increased heat produced by diathermy has a marked effect upon bacteria, by inhibiting their growth and making them less resistant. Diathermy relieves pain, because it absorbs inflammatory exudates and relieves the pressure and consequently increases nutrition. It will relax some parts of the body immediately and will especially relax *cramped muscles where drugs may fail.* It will prevent the development of fibroses which usually follows when there is present any interference with normal nutrition and will also break up and weaken any fibrosis which have already formed. Fibrous

tissue offers greater resistance than normal tissues to the passage of diathermy currents therefore greater heat energy is produced and retained for a much longer period of time.

This retention of heat tends to soften the fibrous tissues. While it is known that the effect of diathermy is the production of heat in the tissues it traverses, still there are other effects which are to be considered. For instance, the oscillating character of the current must induce a forth and back movement of the cells themselves, which increases their chemical as well as their mechanical activity. The changes in the cell are not due merely to the heat energy developed within the tissues but to the mechanical bombardment of the electrons of which the cell is composed.

Baum and Robertson have proven that electrical phenomena dominate cellular activity. *Whenever physiologic inactivity of the cell takes place a pathologic inactivity follows.* The cell then becomes a waste product which must be taken care of by increased activity of the other cells, providing of course, that the other cells are capable of carrying on this extra work.

The effect diathermy has on the different organs may prove of interest to those who really seek a thorough understanding of this subject and will be here briefly described.

The effect of diathermy upon the skin is one of waso-constriction followed by dilation of the capillaries with no marked hyperemia following. A specifical anesthesia is produced, this is of limited proportion. The skin will become tan from repeated applications. Skin bacteria are destroyed when a non-vacuum electrode is applied through very thin clothing, the effect is the same as when applied directly to the skin. When applied through heavy clothing the current becomes extremely irritating and should not be used unless a very strong counter irritant effect is desired.

The Cell. The effect of diathermy upon the cell, which is the physiological working basis of all organism, vegetable as well as animal, is of importance and deserves special study. The cell must have a proper electrical balance, without this it ceases to function.

The human body is considered to be one of the most complete and efficient laboratories there is in existence. Each cell is considered to be a little work shop where the important work of metabolism is carried on.

It is claimed that oxidation and the consequent acidity are parts of the most fundamental processes of the cell and that variations in the relation between the H-ions and OH-ions are of fundamental importance to the function of the cell. The primary function of the cell claims Crile is to fabricate electric energy and if that be the case it may be concluded that the acids produced by oxidation contribute to the production of electric energy just as the acids and bases of a man-made battery contribute to its proper functioning.

The contents of the cell, according to Grover[36], is a colloidal

substance which we shall call protoplasm and has alkeline reaction. The nucleus is composed of chromatin and is acid in reaction. This is probably due to nucleinic acid. The nucleus is located within a mass of protoplasm and is separated from it by a semi-permeable membrane, the potential of the cell is maintained through this membrane.

Under the permeability of the membranes, maintenance of potential and oxidation, depends the vitality of the cell. All of these qualities may be impaired to a very great extent by excessive exercise, anxiety, fear, infection or worry. The normal process of a cell function is oxidation, yet this oxidation process may be overworked to such a great extent that the protoplasm may be changed from its original alkeline reaction to an acid reaction thus changing its electrical potential to such an extent as to destroy its function and possibly the cell itself. This condition is called acidosis and it impairs to a very large extent all cell functions and many cells are destroyed. In order that we may have proper functioning of the cells and to maintain their metabolic efficiency, it is of the utmost importance that there should be a sufficient supply of proper nutrition and an outlet for its waste products, lacking this, the cell ceases to work, its physiologic function is impaired and either becomes diseased or dies.

It is a well established fact that the application of heat to the cell increases oxidation and when the heat is concentrated too much it may cause the destruction of the cell. Diathermy when properly applied will not only increase greatly the supply of fresh arterial blood but also will hasten the escape of waste products through the channels of the dilated capillaries and thus increase cellular efficiency. While the mechanical massaging of the cell by the high frequency current increases its potential which results in an increased metabolic output, yet the fact must not be overlooked that when the application of the current is too prolonged it may cause the cell to become overworked and result in cellular dysfunction. *It is an established clinical and laboratory fact that cellular activity is increased by the application of a moderate degree of heat, and that all electric currents increase metabolism.*

Blood. The application high frequency current causes chemical and physical changes in protoplasm of the red and white cells of the blood. The local application of this current will produce an increased activity of cellular protoplasm. It will also increase the resisting power towards the development of pathological conditions.

The red cells are increased in number, also, the percentage of hemoglobin is increased and nitrogen contents reduced.

Blood Vessels. The first effect of a diathermy application to the blood vessels is one of waso-constriction. This is followed by dilation of the capillaries. The increase in activity in arterial circulation

mechanically relieves venus congestion. Arterial tension may be raised or lowered depending upon the technic of application.

Glands. Diathermy current penetrates deeper than any other electric current and has a more profound effect upon the lymphatic and other glands. Local application increases secretory functions.

Bone. The bones are the last to be heated by the application of diathermy current due to the resistance they offer. The bone, while slower to be heated, retains the heat longer than any other part of the body.

Heart. Diathermy causes fresh oxygenated blood to enter the heart muscles, thereby promoting nutritive effects.

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THE REMOVAL OF MISPLACED LASHES

A by no means uncommon source of ocular irritation is found in the "wild" or misplaced eyelash. These lashes are as a rule very small and patients suffering from these are at times unaware of the cause of the discomfort, complaining of a more or less constant "scratching" or of an inflammation of the conjunctiva. When the eyelashes become displaced so as to turn them inside the lid against the eyeball, the affection is called trichiasis. If, on the other hand, two or more rows of lashes are formed, it goes by the name of distichiasis. Both conditions are very troublesome, as the presence of a single hair which rubs against the anterior surface of the eyeball is enough to completely upset the sufferer. Naturally the offending hairs can readily be removed with a pair of tweezers, but the operation is by no means a simple one. For in the first place the hairs are usually so fine that they require a magnifying glass and oblique illumination to perceive them; and in the second place, unless the ends of the tweezers are roughened and meet accurately together, the hairs will slip through them. When purchasing a pair, according to Dr. Lindsay Johnson[1], they should be first tried on the finest hairs on the inside of the arm, or back of the hand. The best form, he claims, are those with rounded ends having a fairly broad surface of contact, at the ends. These should be roughened by very fine serrations placed horizontally to the grip, which should accurately fit into the corresponding grooves of the opposing piece.

[1]G. Lindsay Johnson. Diseases of Lids. The Optician, p. 99. March 29, 1929.

It is a well known fact that every time they are pulled out the hairs grow in again, but experience shows that they become finer after each time they are removed. Since this method, although quite satisfactory, entails repeated removal time after time, several more effective methods of removal have been devised. The first which is very tedious and painful is to insert a fine hot needle into the hair follicle of each misplaced hair in turn. Another more effective way is to connect the needle with a galvanic battery and when the needle is inserted to place the other (negative) pole anywhere on the eyelid. This method, which is called electrolysis, decomposes the follicle.

A still more effective way is to have a surgeon cut out a long wedge-shaped strip of the eyelid, which is made so as to include all the hair follicles in the cut. Then the two separated edges are sewn together by fine silk sutures. This naturally is the most effective way of all, but the drawback of this operation is that the lid will be forever destitute of lashes. However, the annoyance of the irritation of these "wild" eyelashes is so great in chronic cases of this sort that most patients will prefer the disfigurement to the irritation otherwise set up.

C. C. K.

ABSTRACTS

A CASE OF IRITIS FOLLOWING INJURY AGGRAVATED BY DENTAL FOCI OF INFECTION. R. H. Lieberthal. Bulletin of the New York Optometric Society. Vol. 5, No. 10, pp. 5-6. 1928.

Lieberthal presents a case of a patient, Mr. Z, who in 1918 received an injury by means of a foreign body in the eye. This was removed and the eye treated in the usual way, and instead of it clearing up, an acute condition of Iritis set in which became very stubborn. A physical examination disclosed no foci of infection. A Dental examination made it very apparent that the focus was coming from that direction. Infected roots, and a "pus" pyorrhetic condition was responsible for the decision for removing all of the teeth, and within two weeks the Iritis cleared up.

T. O. B.

THE OPTOMETRIC CHILD SPECIALIST. P. H. Beyhan. The Optometric Digest. Vol. 1, No. 3, pp. 5-6. 1928.

Beyhan suggests that certain optometrists be specially trained to refract and treat muscular imbalances in children, feeling as he does that the handling of these cases is in a sense a distinct specialty with technics quite at variance from the usual optometric procedure.

T. O. B.

ANNOTATIONS AND SOCIETY PROCEEDINGS

The American Journal of Optometry is the Official Organ of the American Academy of Optometry, as well as the Organ of the Arkansas, Delaware, Indiana, Iowa, Maine, Maryland, Michigan, Minnesota, Nebraska, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont and West Virginia Optometric Associations.

The following gentlemen have consented to supply items of interest from their respective sections, acting in the capacity of

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OPTOMETRIC CONGRESS OF A. O. A.

The Thirty-second Annual Convention of the American Optometric Association was held in Philadelphia, Pa., during the latter part of June. This optometric gathering was one of the largest held in recent years and the optometrists of Pennsylvania are to be indeed congratulated for their splendid hospitality and for the ideal convention arranged for the visiting delegates.

The meeting was outstanding for its educational features, which were held under the auspices of the Pennsylvania State College of Optometry. The following papers were presented: "Optometric Jurisprudence," by Dr. A. M. Skeffington; "Illumination," by Mr. W. Harrison; "Photometric Retinal Sensitivity," by Dr. F. L. Mason; "Dissection of Cadaver," by Dr. C. R. Ellis; "Ophthalmoscopy, Fundus Diagnosis," by Dr. W. B. Needles; "Brain Dissection," by Dr. R. M. Peckham; "Visual Field Work," by Dr. W. B. Needles; "Spinal Reflexes," by Dr. E. F. Tait; "Ophthalmometry and Astigmatism," by Dr. Theodore F. Klein; "Ocular Muscles," by Dr. R. M. Peckham.

Another outstanding event during the convention were the commencement exercises of the Pennsylvania State College to which all delegates were invited and at which Dean Albert Fitch presided.

At the closing session of the convention, the delegates reelected all the officers and trustees with but one exception. The officers for the ensuing year are: Dr. Geo. S. Houghton, president; Dr.

Wm. M. Kinney, second vice-president; Dr. Edwin T. Meyer, secretary; Dr. Ernest H. Kiekenapp, secretary, and Dr. Fred A. Stengel, treasurer.

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UNIVERSITY OF ROCHESTER

The Board of Regents of the University of Rochester have decided to differentiate between those groups of students who are taking optometry and those who wish to prepare themselves for industrial application of science of optics itself. As far as we know, this is the first time this distinction has been made in any of the large universities now teaching optometry. This announcement is made as follows in their recent university bulletin: "Special courses in Optics leading to the degree Bachelor of Science are offered in the department of physics to some students (a) who wish to prepare themselves for industrial application of optics, or (b) who wish to prepare for licensure as registered optometrists. These courses are made possible by the co-operation of the Eastman Kodak Company and the Bausch & Lomb Optical Company, in financing the undertaking and in making available certain services by members of their scientific staffs."

* * * * * *

A CORRECTION

Dr. R. M. Peckham informs us that in the printed report of his paper presented at the 1927 meeting of the American Academy of Optometry, there has been an unfortunate error made.

On page 354 of the June, 1929, issue of the American Journal of Optometry, the fourth line, last word, which now reads "more" should be changed to read "less." Members of the Academy will find this sentence on page 45 of the transactions of the Academy, Volume 2. The full sentence should read: "Now we can conceive of two reasons why we often find less latent hyperopia after three or four days use of atropine."

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NORTH DAKOTA CONVENTION

The Annual Convention of the North Dakota Optometric Association will be held in Fargo, N. D., on the fifth and sixth of August. Dr. Carel C. Koch of Minneapolis will be the speaker, his subjects being "The Optometric Treatment of Unusual Cases," and "A Routine Refraction." The annual North Dakota Golf Tournament will be held during the convention.

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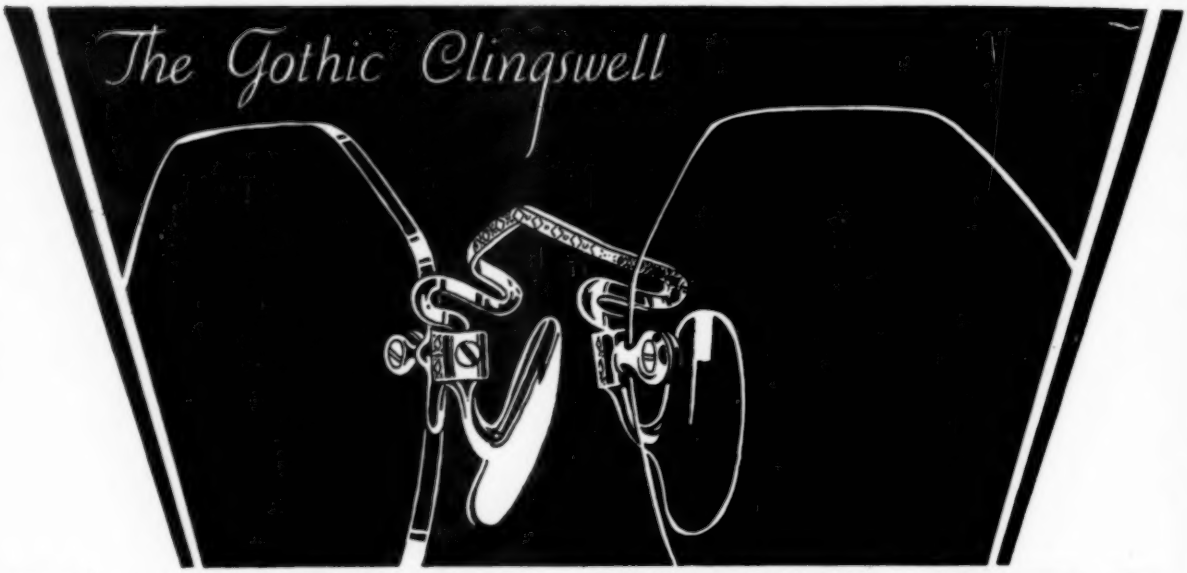
NORTH DAKOTA STATE BOARD EXAMINATIONS

The North Dakota State Board examinations will be held at the Gardner Hotel, Fargo, on August 7th and 8th, immediately following the state convention, according to Dr. H. Kornmesser, the secretary of the Board.



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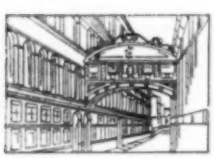
Bridge of Sighs

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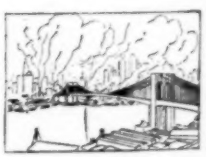
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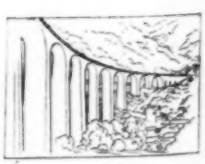
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